(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
1 November 2001 (01.11.2001)

PCT

(10) International Publication Number
WO 01/81735 A1

(51) International Patent Classification[7]: F01N 3/01, B03C 3/017, 3/019

(21) International Application Number: PCT/GB01/01770

(22) International Filing Date: 20 April 2001 (20.04.2001)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
0009826.9 25 April 2000 (25.04.2000) GB

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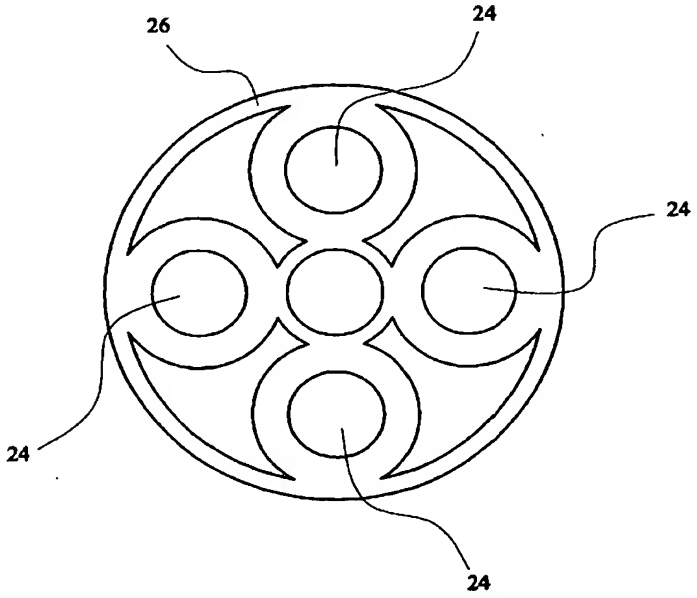
(81) Designated States *(national)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.

(84) Designated States *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published:
— *with international search report*
— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments*

[Continued on next page]

(54) Title: IMPROVEMENTS IN AND RELATING TO PARTICULATES IN EXHAUST STREAMS



(57) Abstract: The present invention discloses an apparatus for transferring particulates in an exhaust stream, the apparatus comprising an exhaust stream flowpath, means (34) for charging at least some particulates within the exhaust stream and means (4) for focusing at least some of the charged particulates.

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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

IMPROVEMENTS IN AND RELATING TO PARTICULATES IN EXHAUST STREAMS

Field of the Invention

The present invention relates to apparatus and methods for the removal of particulates from and the transfer of particulates in exhaust streams. In particular, but without limitation, the present invention relates to the removal of particulates from and transfer of particulates in vehicle exhaust gas streams.

Background to the Invention

There is a growing public awareness of the need for a substantial proportion of particulates to be removed from petrochemical engine driven vehicle exhaust gas streams prior to emission of said gas streams because of the health risks that can arise. The particles of most concern are those in the range PM 10-PM 2.5. There are associated moves within the industries involved, especially vehicle and engine manufacturers, and from regulatory authorities to improve the performance of particulate removal.

To date most attention has been concentrated on the use of filters as a way of achieving particulate reduction from exhaust gas streams. These filters have been proven to be unsatisfactory because they require too frequent cleansing or exchange and they have an undesirable effect on exhaust gas pressures. The presence of the filter, and even more so as it becomes progressively clogged, results in a pressure drop across the filter and a resultant back pressure which reduces engine performance and can cause an

increase in waste emissions contrary to the intention of the device.

Clearly there is a requirement for an improved apparatus and process for the removal of particulates from exhaust stream gases. It is an aim of preferred embodiments of the present invention to provide such improved apparatus and methods and apparatus and methods for use therein.

Summary of the Invention

According to the present invention in a first aspect, there is provided an apparatus for transferring particulates in an exhaust stream, the apparatus comprising an exhaust stream flowpath, means for charging at least some particulates within the exhaust stream and means for focusing at least some of the charged particulates.

By focusing the particulates a concentrated stream is created that is easier to handle. If the focused stream is away from the surface of the channel it can be handled in such a way as to minimise back-pressure.

Suitably, the focusing means comprises electromagnetic focusing means. Suitably, the electromagnetic focusing means comprises at least one charged plate. Suitably, the at least one charged plate is in the exhaust stream flowpath. Suitably, the electromagnetic focusing means comprises a plurality of electromagnetic focusing means along the exhaust stream flowpath. Suitably, the electromagnetic focusing force exerted by the plurality of electromagnetic focusing means varies between said

electromagnetic focusing means. Suitably, the focusing force is graduated along the exhaust stream flowpath.

Suitably, the exhaust stream flowpath is defined at least in part by a tubular body. Suitably, the at least one focusing means is or are located along the length of the tubular body. Suitably, the tubular body is preceded (relative to the exhaust stream flowpath) by an entry chamber. Suitably, the tubular body is followed (relative to the exhaust stream flowpath by a collection chamber. Suitably, a baffle plate is provided between the tubular body and the collection chamber. Suitably, a generally conical concentrator head is provided between the tubular body and the collection chamber. Suitably, the concentrator head is provided between the baffle plate and the collection chamber. Suitably a particulate flowpath is provided through a hole in said baffle plate.

Suitably, the focusing means is adapted to focus particulates to a region of the exhaust stream flowpath. Typically this will be a longitudinal region. Suitably, said region is spaced from the side walls of the tubular body. Suitably, said region is substantially central relative to the exhaust stream flowpath.

Suitably, the apparatus provides an exhaust gas exit flowpath discrete from a particulate flowpath. Suitably, the exhaust gas exit flowpath is defined by an exhaust gas flowpath chamber.

Suitably, a pump or the like is provided to transfer agglomerated particulate to another location. Suitably, the other location is a collector. Suitably, the collector

is in fluid communication with the sump via a fluid communication channel comprising a releasable valve, whereby the collector can be removed from the fluid communication channel. Suitably, the collector comprises an expandable sack. Suitably, the collector comprises a one-way valve permitting the ingress of agglomerated particulate, but not allowing egress therefrom of agglomerated particulate. Suitably, the one-way valve comprises a membrane.

Suitably, the apparatus is located in a vehicle silencer.

Suitably, a gap is provided between the exit of the tubular body and the baffle plate.

According to the present invention in a second aspect, there is provided apparatus for collecting particulates from an exhaust stream, the apparatus comprising means for separating at least some of the particulate from the exhaust stream, a sump for collecting agglomerated particulate and means for transferring agglomerated particulate from the sump to another location.

Suitably, the apparatus according to the second aspect of the invention is modified according to the first aspect of the invention.

According to the present invention in a third aspect, there is provided a vehicle comprising an apparatus according to the first or second aspects of the invention.

Suitably, the vehicle comprises a petrochemical engine the exhaust flow of which is in fluid communication with the apparatus according to the first or second aspects of the invention.

According to the present invention in a fourth aspect, there is provided a method for transferring particulates in an exhaust stream, the method comprising charging at least some particulates within an exhaust stream for focusing at least some of the charged particulates.

Suitably, the focusing means comprises electromagnetic focusing means. Suitably, the electromagnetic focusing means comprises at least one charged plate. Suitably, the at least one charged plate is in the exhaust stream flowpath. Suitably, the electromagnetic focusing means comprises a plurality of electromagnetic focusing means along the exhaust stream flowpath. Suitably, the focusing is provided by electromagnetic focusing means and the electromagnetic focusing force exerted by the plurality of electromagnetic focusing means varies between said electromagnetic focusing means. Suitably, the focusing force is graduated along the exhaust stream flowpath. Suitably, the at least one focusing means is or are located along the length of a tubular body.

Suitably, the exhaust gas enter an entry chamber before the tubular body.

Suitably, the focusing means focuses particulates to a region of the exhaust stream flowpath. Typically this will be a longitudinal region. Suitably, said region is spaced from the side walls of the tubular body. Suitably, said

region is substantially central relative to the exhaust stream flowpath.

Suitably, agglomerated particulate is transferred to another location. Suitably, the other location is a collector. Suitably, the collector is in fluid communication with the sump via a fluid communication channel comprising a releasable valve, whereby the collector can be removed from the fluid communication channel. Suitably, the collector comprises an expandable sack. Suitably, the collector comprises a one-way valve permitting the ingress of agglomerated particulate, but not allowing egress therefrom of agglomerated particulate. Suitably, the one-way valve comprises a membrane.

Suitably, the apparatus is located in a vehicle silencer.

According to the present invention in a fifth aspect, there is provided a method for collecting particulates from an exhaust stream, the method comprising the steps of separating at least some of the particulate from the exhaust stream, collecting agglomerated particulate in a sump and transferring agglomerated particulate from the sump to another location.

Suitably, the method according to the fifth aspect of the invention is modified according to the fourth aspect of the invention.

Brief Description of the Drawings

The present invention will now be described, by way of example only, with reference to the drawings that follow; in which:

Figure 1 is a schematic illustration of an apparatus according to a first embodiment of the present invention.

Figure 2 is an end elevation of the particulate remover of the embodiment of the present invention shown in Figure 1.

Figure 3 is a cross sectional elevation on the line III-III of Figure 2.

Figure 4 is a view similar to Figure 3 of a second embodiment of the invention.

Description of the Preferred Embodiments

Referring to Figure 1 of the drawings that follow, there is shown an exhaust stream gas flowpath inlet 2 (typically through the first stage of a vehicle exhaust) from a petrochemical vehicle engine (not shown) in fluid communication with a particulate concentrator indicated generally at 4 and which is typically located in the silencer unit of a vehicle exhaust. The particulate remover is in fluid communication with an exhaust stream gas flowpath outlet 6 and a particulate outlet flowpath 8.

The particulate outlet flowpath 8 comprises tubing 10 connecting particulate concentrator 4 with a two stroke air

operated pump 12, which in turn is connected via tubing 14 to a collector vessel 16. The collector vessel 16 comprises a flexible inner sac 18 for containing agglomerated particulate material and a rigid outer container 20 which protects sac 18 and can be used for mounting the vessel 16. Tubing 14 is connected to vessel 16 by a quick-release hand-operated valve 22. The entry to the sac 18 comprises a one-way membrane valve (not shown) which permits therethrough agglomerated particulate, but will note permit its egress.

Referring to Figure 2 of the drawings that follow there is shown a cross section of particulate concentrator 4 from which it can be seen that the concentrator 4 comprises four substantially identical longitudinal tubular channels 24 mounted within circular cylindrical outer casing 26.

Referring to Figure 3 of the drawings that follow, a longitudinal cross-section of particulate concentrator 4 is shown. In the concentrator 4 two of the four channels 24 are visible within casing 26 in Figure 3. Each channel 24 is substantially similar to the others and so only one will be described in detail herein. In Figure 3 arrows, such as that indicated at 28, show the flow and movement of gases and particulate as will be described hereinafter.

Immediately after the gas flow inlet 2 there is a gas inlet chamber 30 from which outlets 32 are provided into channels 24. Electrically charged coronas 34 project through inlet chamber 32 into each of channels 24. Internal gas impervious walls 36 ensure the gas stream enters channels 24. The coronas are believed to need to be

in the input gas system, but the location, number and configuration of the coronas can vary between applications.

Each channel 24 comprises a generally circular cylindrical hollow tube defined by exterior wall 38. At the end distant from outlet 32 there is a channel outlet 42 which is fluid communication with agglomeration chamber 44 via an expansion chamber 46 providing a gap between outlet 42 and a baffle plate 48 which divides expansion chamber 46 from agglomeration chamber 44. In baffle plate 48 is a hole 50 (aligned with inlet 32) to provide fluid communication between expansion chamber 46 and agglomeration chamber 44.

In each channel 24 are a plurality, in this case four are shown, of tubular electrically charged focusing elements 52 mounted on radial stalks 53. Along the length of the channel 24 in a downstream direction (relative to the exhaust flow) the focusing elements 52 are of smaller diameter. Each element 52 is equidistantly spaced from the centre of the channel 24.

About channels 24 are exhaust gas outlet chambers 54 which are circular cylindrical, surrounding channels 24. Exhaust gas outlet chambers 54 are in fluid communication with expansion chamber 46 via outlets 56. Exhaust gas outlet chamber 56 are in fluid communication with exhaust gas outlet channel 58 via a plurality of holes 60 in the channel 58. Exhaust gas outlet channel 58 leads to atmosphere.

The agglomeration chamber 44 includes a sump region 62 for gathering agglomerated particulate. The chamber 44 also includes pressed depressions 64 aligned with holes 50.

A mode of operation of the first embodiment of the present invention will now be described.

Exhaust gas is generated from a petrochemical vehicle engine (not shown) as is well known and amongst the exhaust gas is entrained particulate material. The exhaust gas with entrained particulates flows along the exhaust gas flowpath to exhaust stream gas flowpath inlet 2 into gas inlet chamber 30 from where it flows into channels 24 via outlets 32. As the exhaust stream passes through the inlet chamber 30 it is subjected to an electric field by the coronas 34 and substantial numbers of the particulates are thereby charged by the coronas 34. Surprisingly it has been found that the particulates maintain this charge for long enough that they can be manipulated by electromagnetic fields during their dwell time in the particulate concentrator 4. As the gas stream and (now charged) entrained particulate material passes along the channel 24 it is subject to electric fields generated by the focusing elements 52. The voltage and current to the focusing elements 52 is set (relative to that of the coronas 34) to urge the charged particulates towards the centre of the flowstream to converge towards a narrow stream of charged particulate material. The exhaust gas flows out of the end 42 of channel 24. The majority of that gas flow impinges on baffle plate 48 and exits expansion chamber 46 via outlets 56 to exhaust outlet 54. From outlet 6 the exhaust gases proceed to the remainder of the normal exhaust system.

The particulate material impinges on the walls of collecting chamber 44, agglomerates and falls to particulate sump region 62 at the foot thereof. From there it is transferred to sac 18 in container 20 by pump 12. The pump 12 serves to compress the agglomerated particulate in sac 18. The agglomerated particulate has the consistency and viscosity of a thick (relative to water) liquid and can be pumped adequately by a relatively low power pump.

The agglomerate can be gathered in sac 18 until full and then a new collector vessel 16 can be exchanged for the original. If the container 20 has a removable base the sac only can be removed therefrom and a new sac 18 used. As an alternative the collector vessel 16 can be removed from tubing 14 and the sac 18 emptied. The collector vessel 16 can then be re-attached to tubing 14 for future use.

Referring to Figure 4 of the drawings that follow there is shown a concentrator generally similar to that shown in Figure 3, in relation to which corresponding reference numerals are used for similar parts.

In Figure 4 the collector 4 differs in that the focusing elements in this case comprise bands 100 circumferentially located on (or in or around) the channels 24. The focusing strength, ie electromagnetic field strength at the centre of the flowpath is increased downstream by increasing the field strength of each respective band 100.

Another difference is that the holes 50 in the baffle plate 48 are larger, but in agglomeration chamber 44 by each hole 50 are generally conically shaped funnel concentrators 102 for further agglomerating and concentrating particulates impinging thereon. Residual exhaust gas velocity encourages the agglomerated particulate to leave funnel concentrators 102 at their exits 104.

The gap between baffle plate 48 and the entry to funnel concentrator 102 is provided, in conjunction with expansion chamber 46, to minimise an unwanted fluid flow effects.

In the Figure 4 embodiments there are a plurality of coronas 34, in this case projecting into channels 24.

The charge on the focusing elements is set as a design choice according to the design of the apparatus, engine configuration etc.

In some instances it may be possible to use magnets in place of the electrically charged focusing elements.

Coronas can be placed anywhere in the flowpath up to the focusing elements.

The number and dimensions of channels 24 can vary according to the engine configuration, and design choice.

The present invention is particularly of use in relation to diesel engines, but can also find application with other petrochemical engines, and with other exhaust systems.

The reader's attention is directed to all papers and documents which are filed concurrently with or previous to this specification in connection with this application and which are open to public inspection with this specification, and the contents of all such papers and documents are incorporated herein by reference.

All of the features disclosed in this specification (including any accompanying claims, abstract and drawings), and/or all of the steps of any method or process so disclosed, may be combined in any combination, except combinations where at least some of such features and/or steps are mutually exclusive.

Each feature disclosed in this specification (including any accompanying claims, abstract and drawings), may be replaced by alternative features serving the same, equivalent or similar purpose, unless expressly stated otherwise. Thus, unless expressly stated otherwise, each feature disclosed is one example only of a generic series of equivalent or similar features.

The invention is not restricted to the details of the foregoing embodiment(s). The invention extends to any novel one, or any novel combination, of the features disclosed in this specification (including any accompanying claims, abstract and drawings), or to any novel one, or any novel combination, of the steps of any method or process so disclosed.

Claims

1. An apparatus for transferring particulates in an exhaust stream, the apparatus comprising an exhaust stream flowpath, means for charging at least some particulates within the exhaust stream and means for focusing at least some of the charged particulates.

2. An apparatus according to claim 1, in which the focusing means comprises electromagnetic focusing means.

3. An apparatus according to claim 2, in which the electromagnetic focusing means comprises at least one charged plate.

4. An apparatus according to claim 3, in which the at least one charged plate is in the exhaust stream flowpath.

5. An apparatus according to any preceding claim, in which the electromagnetic focusing means comprises a plurality of electromagnetic focusing means along the exhaust stream flowpath.

6. An apparatus according to any one of claims 1 to 4, in which the electromagnetic focusing force exerted by the plurality of electromagnetic focusing means varies between said electromagnetic focusing means.

7. An apparatus according to claim 6, in which the focusing force is graduated along the exhaust stream flowpath.

8. An apparatus according to any preceding claim, in which the exhaust stream flowpath is defined at least in part by a tubular body.

9. An apparatus according to claim 8, in which the at least one focusing means is or are located along the length of the tubular body.

10. An apparatus according to claim 8 or claim 9, in which the tubular body is preceded (relative to the exhaust stream flowpath) by an entry chamber.

11. An apparatus according to any one of claims 8 to 10, in which the tubular body is followed (relative to the exhaust stream flowpath by a collection chamber.

12. An apparatus according to claim 11, in which a baffle plate is provided between the tubular body and the collection chamber.

13. An apparatus according to claim 12, in which a generally conical concentrator head is provided between the tubular body and the collection chamber.

14. An apparatus according to claim 13, in which the concentrator head is provided between the baffle plate and the collection chamber.

15. An apparatus according to claim 12 or claim 13, in which a particulate flowpath is provided through a hole in said baffle plate.

16. An apparatus according to any preceding claim, in which the focusing means is adapted to focus particulates to a region of the exhaust stream flowpath.

17. An apparatus according to claim 16, in which said region is spaced from the side walls of the tubular body.

18. An apparatus according to claim 16 or claim 17, in which said region is substantially central relative to the exhaust stream flowpath.

19. An apparatus according to any preceding claim, in which the apparatus provides an exhaust gas exit flowpath discrete from a particulate flowpath.

20. An apparatus according to claim 19, in which the exhaust gas exit flowpath is defined by an exhaust gas flowpath chamber.

21. An apparatus according to any preceding claim, in which a pump or the like is provided to transfer agglomerated particulate to another location.

22. An apparatus according to claim 21, in which a collector is in fluid communication with the pump via a fluid communication channel comprising a releasable valve, whereby the collector can be removed from the fluid communication channel.

23. An apparatus according to claim 22, in which the collector comprises an expandable sack.

24. An apparatus according to claim 23, in which the collector comprises a one-way valve permitting the ingress of agglomerated particulate, but not allowing egress therefrom of agglomerated particulate.

25. An apparatus according to claim 24, in which the one-way valve comprises a membrane.

26. An apparatus according to any preceding claim, in which the apparatus is located in a vehicle silencer.

27. An apparatus according to any one of claims 12 to 14, in which a gap is provided between the exit of the tubular body and the baffle plate.

28. Apparatus for collecting particulates from an exhaust stream, the apparatus comprising means for separating at least some of the particulate from the exhaust stream, a sump for collecting agglomerated particulate and means for transferring agglomerated particulate from the sump to another location.

29. The apparatus according to claim 28 is modified according to any one of claims 1 to 27.

30. A vehicle comprising an apparatus according to any one of claims 1 to 29.

31. A vehicle according to claim 30, in which the vehicle comprises a petrochemical engine the exhaust flow of which is in fluid communication with the apparatus according to any one of claims 1 to 29.

32. A method for transferring particulates in an exhaust stream, the method comprising charging at least some particulates within an exhaust stream for focusing at least some of the charged particulates.

33. A method according to claim 32, in which the focusing means comprises electromagnetic focusing means.

34. A method according to claim 33, in which the electromagnetic focusing means comprises at least one charged plate.

35. A method according to claim 34, in which the at least one charged plate is in the exhaust stream flowpath.

36. A method according to claim 33, in which the electromagnetic focusing means comprises a plurality of electromagnetic focusing means along the exhaust stream flowpath.

37. A method according to claim 36, in which the focusing is provided by electromagnetic focusing means and the electromagnetic focusing force exerted by the plurality of electromagnetic focusing means varies between said electromagnetic focusing means.

38. A method according to claim 32, in which the focusing force is graduated along the exhaust stream flowpath.

39. A method according to claim 38, in which the at least one focusing means is or are located along the length of a tubular body.

40. A method according to claim 39, in which the exhaust gas enter an entry chamber before the tubular body.

41. A method according to claim 32, in which the focusing means focuses particulates to a region of the exhaust stream flowpath.

42. A method according to claim 41, in which said region is spaced from the side walls of the tubular body.

43. A method according to claim 41 or claim 42, in which said region is substantially central relative to the exhaust stream flowpath.

44. A method according to claim 32, in which agglomerated particulate is transferred to another location.

45. A method according to claim 44, in which a collector is in fluid communication with the sump via a fluid communication channel comprising a releasable valve, whereby the collector can be removed from the fluid communication channel.

46. A method according to claim 45, in which the collector comprises an expandable sack.

47. A method according to claim 45, in which the collector comprises a one-way valve permitting the ingress of agglomerated particulate, but not allowing egress therefrom of agglomerated particulate.

48. A method according to claim 47, in which the one-way valve comprises a membrane.

49. A method according to any one of claims 32 to 48, in which the apparatus is located in a vehicle silencer.

50. A method for collecting particulates from an exhaust stream, the method comprising the steps of separating at least some of the particulate from the exhaust stream, collecting agglomerated particulate in a sump and transferring agglomerated particulate from the sump to another location.

51. A method according to claim 50, in which the method according to claim 50 is modified according to any one of claims 32 to 49.

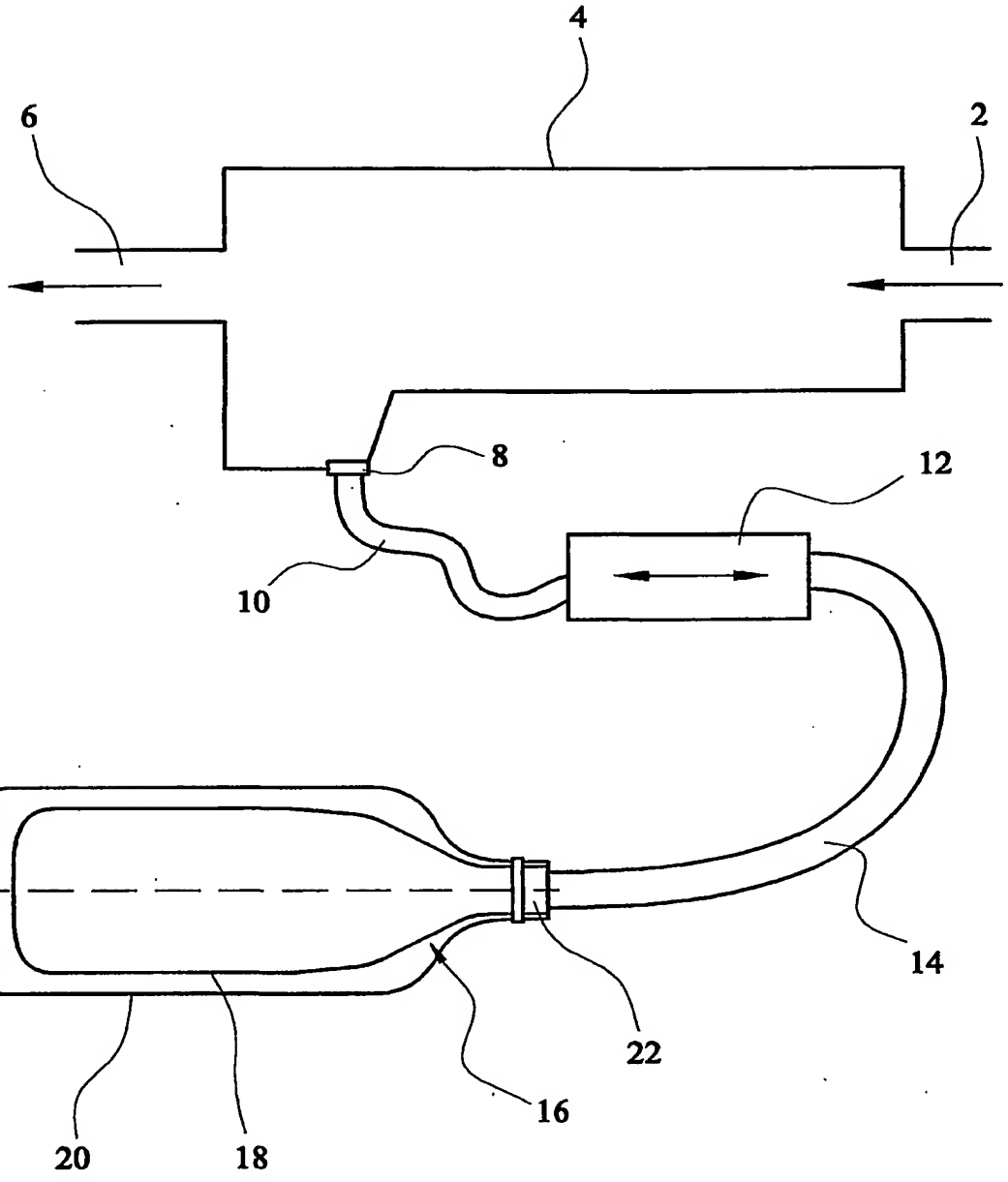

FIG. 1

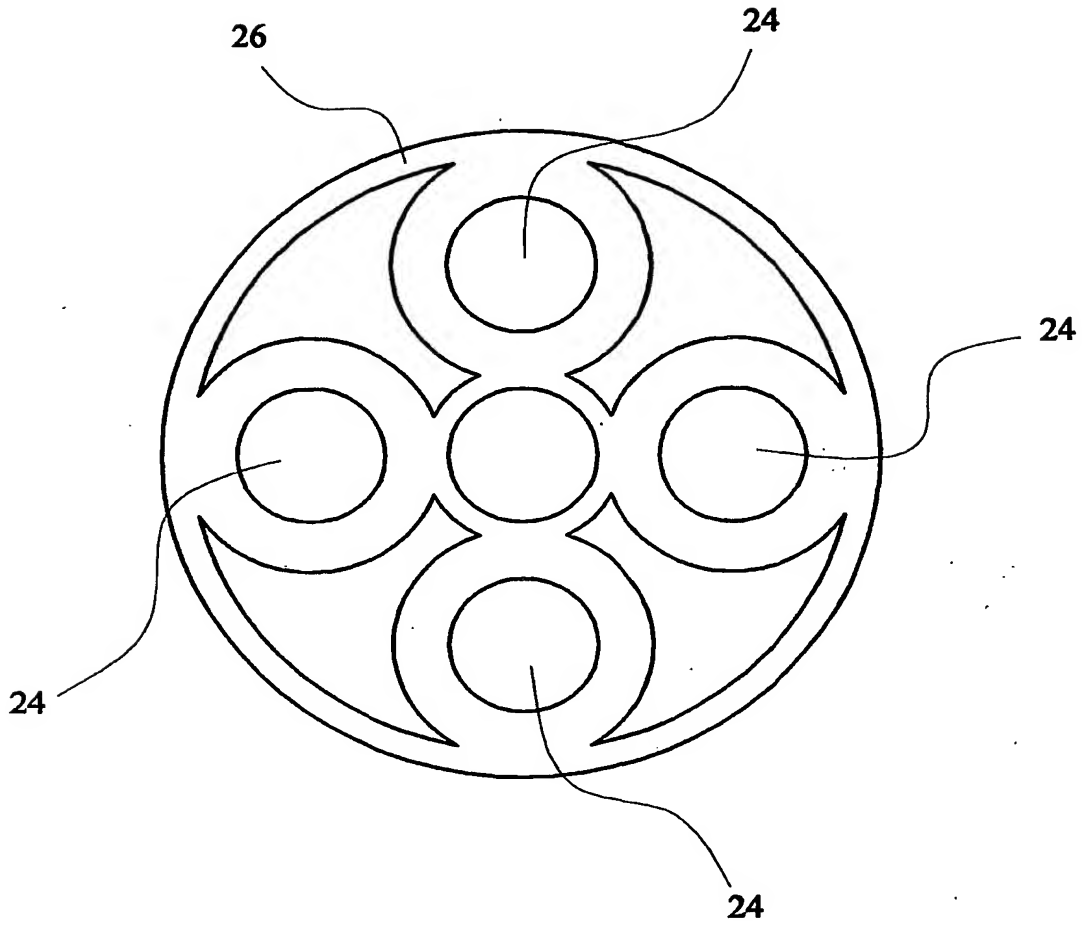

FIG. 2

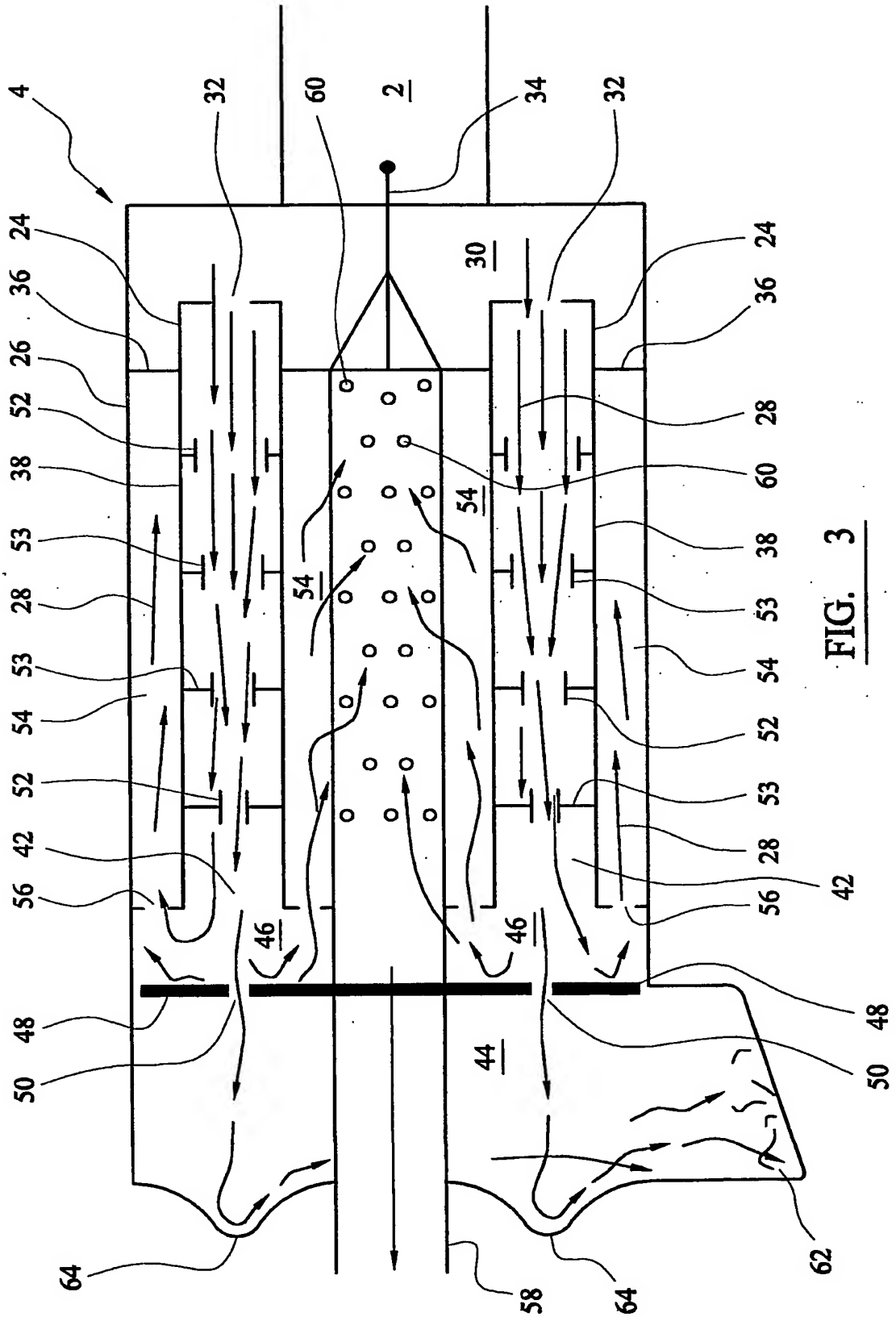
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FIG. 3

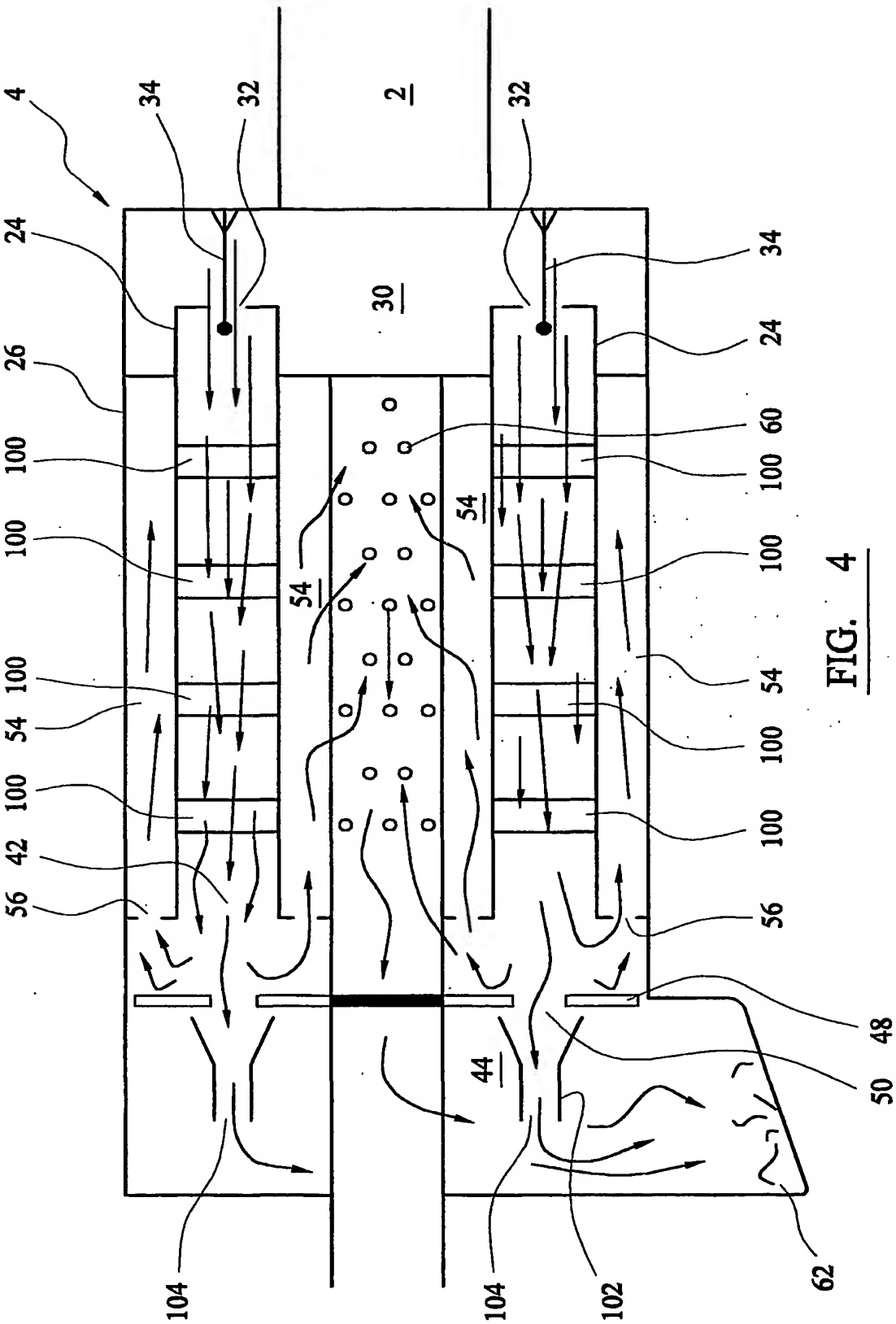
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FIG. 4

INTERNATIONAL SEARCH REPORT

	ational Application No PCT/GB 01/01770

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 F01N3/01 B03C3/017 B03C3/019

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 F01N B03C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4 734 105 A (ELIASSON BALDUR ET AL) 29 March 1988 (1988-03-29) column 2, line 3 -column 2, line 56; figures 13-16 column 7, line 45 -column 8, line 45	1-11, 19-21, 28, 30-39, 41-44,50
X	DE 37 37 343 A (BBC BROWN BOVERI & CIE) 26 May 1988 (1988-05-26) abstract; figure 6	1,28,32, 50
P,X	GB 2 346 821 A (NOTETRY LTD) 23 August 2000 (2000-08-23) abstract; figure 1A	1,28,32, 50

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[X] Further documents are listed in the continuation of box C. [X] Patent family members are listed in annex.

* Special categories of cited documents :

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Date of the actual completion of the international search	Date of mailing of the international search report
23 July 2001	22/08/2001

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Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

International Application No
PCT/GB 01/01770

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
X	US 4 622 051 A (ZIMMERMANN KLAUS-DIETER ET AL) 11 November 1986 (1986-11-11) column 2, line 49 -column 3, line 29; figure 1	1,28,32, 50
X	US 4 718 923 A (LEONHARD ROLF ET AL) 12 January 1988 (1988-01-12) column 3, line 20 -column 4, line 46; figures 1,2	1,28,32, 50
X	EP 0 147 424 A (BOSCH GMBH ROBERT) 10 July 1985 (1985-07-10) column 3, line 4 -column 3, line 25; figure 1	1,28,32, 50
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A	OHKUBO T ET AL: "THE ELECTROSTATIC AGGLOMERATION OF FINE PARTICLES INSIDE ESP WITH A BI-POLAR CHARGING SECTION" PROCEEDINGS OF THE INTERNATIONAL CONFERENCE ON ELECTROSTATIC PRECIPITATION,CH,BEIJING, INTERNATIONAL ACADEMIC, vol. CONF. 4, 14 September 1990 (1990-09-14), pages 590-596, XP000214580 the whole document	1,28,32, 50

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/GB 01/01770

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